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PHYSICAL PROPERTIES OF PEANUTS RELATED TO HARVESTING MECANIZATION

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SUMMARY:

This study on the mechanical properties of peanuts intended complete information on the suitability to mechanize the varieties that had been of interest in the production tests made in Valencia (Spain). The results obtained established the basis for a breeding program.

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Materials and methods

The eight following varieties were tested, which represent a wide range of types: Argentine, Palma (Spanish); Cacahua (Valencia); NC-2, Bunch G-2, Virginia Jumbo, Moruno, GA-119-20 (Virginia). As it can be seen, some of these varieties are from American origin, and some are local varieties from Spain.

For the measures of detachment force, manual dynamometers of 500, 1000 and 2000 g were used: the maximum force at the detachment of the pod from its union with the peduncle or peg was determined in the tests. The plants were smoothly dug, left on the ground for drying 24 hrs and tested in the field. Four pods of each plant were always measured, in whole maturity and without any damage.

Compression testing of the plants was made with a universal testing machine (*) with a disc of 5 cm in diameter; operatimg velocity was 1 mm/s for compression of the pods in two positions: carpelar suture parallel to the compression planes, and suture perpendicular to them. Maximum force at rupture or failure was determined.

Two special testing devices were constructed: A rotating parallelepipedic prism made of iron angle and wire mesh, mounted on a diagonal axis (fig, 1) with an electric motor and rotating speed of 47 r/min, in which 40 pods of each variety were subjected to impact plus friction. The test lasted 3 hours, with examination of the damages each half an hour;

A laboratory picking device formed basically of three cylinders with elastic fingers, and there corresponding concaves in line, that can be made independent by adjustable metal plates, so that it is possible to work with one, two or three cylinders, and also recover separately the three fractions of the threshed product (fig. 2). The tests with this machine consisted basically in the picking (or threshing) of a number of plants (around 20) that represent 1.5 - 2 kg each time, the recovering and cleaning of the pods, and the classification for damage in three groups : 1) "without damage", 2) "small punctures" or "scrapings" and 3) "holes", "broken pods", etc., which were weighed, and expressed in percentage of total weight. Four rotating velocities of the cylinders : 350, 450, 550 and 650 r/min (equivalent to : 7.5, 9.6, 11.8 and 13.6 m/s of peripheral velocity respectively), with four replications were used in each test.

In all cases, analysis of variance of the data was performed.

Results and discussion

1. Detachment force (f. d.) of the pods for the different varieties. Table 1

(*) LTCM Chatillon Universal Stand

gives the mean values of the f. d. for the eight varieties determined in one year (randomized blocks and 80 determinations per variety were used). Therefore, it can be stated that the differences of mean f. d. between the varieties in the time of harvest are very important, and not correlated with the mean pod-size of the variety.

Further, the variation of the f. d. during the drying period (of the plants before picking) was studied. Figure 3 shows the correlation between moisture (or date of testing) and f. d. values for two varieties, during a drying period (whole plants in open storeroom) of 20 days. In the last date, the f. d. is aproximately 50% of its initial value for both varieties.

Also the variation of the f. d. during the last period of maturation of the plants in the soil was studied: for 6 varieties, dug in 4 dates separated one week, the f. d. was determined. There is a slight (only statistically significant for variety NC-2) but clear decrease of the f. d. during this period for all varieties tested. This decrease is no greater than 200 g for this - last four-week period.

2. Length of the pegs or peduncles(l. p.)

Having measured the first year the depth and width of the clod of pods and soil for each variety (table 2), we could state the grouping of the varieties in the Spanish(plants always erect) and Virginia, (with bigger clod). All the varieties were cultivated in single rows, (62. 5 cm between rows), and with ground irrigation.

The values for the second year were smaller (low production was general this year) but the grouping of the varieties turned out the same. The third year, the length of 50 pegs from different random plants of each variety were measured. The correlation between mean width of the clod and l. p. for the eight varieties is highly significant. Not so with the depth. (Table 2).

3. Resistance of the pods to compression.

The measures were always taken in the two positions described: there are varieties with high compression resistance in parallel position (Palma) and others with a very similar resistance in both positions (Cacahua) (table 3). There appears a significant influence of locality (temperatures and type of soil) on the resistance characteristics of the pods.

In the tests of compression in vertical position, it is measured mainly the resistance of the suture to "opening". This resistance increases (highly in Palma and Bunch G-2, and less in the rest) with drying.

In the tests in horizontal position the characteristic resistance of the shell,

as well as the resistance of the suture, the position of the seeds inside and the form of the pod are contributing factors, so that this measure becomes the most variable. The differences between varieties appear though highly significant.

4. Resistance to repeated impacts and friction.

This test was made to know the less resistant pods and where they fail in - mechanical manipulation. The results were interesting, also because of their agreement with the compression results. Table 4 shows the results of these tests, with the eight varieties. Moisture of the pods was low. (10%).

Column 1 shows the specific resistance of each variety (fruits without damage). Column 2, 3 and 4 show the relative importance of each type of damage. Column 5 represents the ease of failure of the pods.

The progressive incidence of each type of damage is shown in figure 5.

5. Mechanical picking.

With the laboratory picker and the method described; the eight varieties were tested for their adaptation to actual mechanical harvesting, related with the mechanical properties studied. Figure 6 shows the results of a) four earlier varieties in good dessication condition, low moisture; b) four varieties, later in ripening and with high moisture.

The results of these tests could be summarized as follows:

- The effect of moisture of pods and plants is most important on the incidence of damage. The losses were higher moisture content, and were also related to the size of the pods. All this was an evidence that damage is more because of compression of the pods, passing through too narrow clearances and not so much because of impacts. This indicates the need of adjusting the different parts of the machine to the pod characteristics of the variety. On the other hand, the compression tests were very indicative of the specific resistance of each variety to mechanical harvesting.

- The efficiency of picking was very high in all cases, also at the minimum peripheral velocity of the cylinders, in which the damages are low, also in the cases when the crop is in conditions of high moisture, as is the case of the Valencia area of Spain.

Conclusions

a) With the method of mechanical picking now used (cylinders with elastic fingers), which has a high picking efficiency, highest values of f. d. would be desirable: Argentine, Bunch G-2, NC-2, so that as few pods as possible would be lost at digging, inverting, windrowing, etc.

b) Peripheral velocities of the picking cylinders could be as high as 11 m/s for crops medium to high dessicated. With crops with higher moisture, lowest peripheral velocities should be used (7.5 m/s).

c) The verieties with most resistant pods to compression and dynamic manipulation were GA-119-20 and Palma (pods of "compact" form). Argentine, with very small pods, could be also good mechanized.

d) The length of the pegs or peduncles could be used as a measure of the concentration of the pods at the base of the plant; desirable not only because of cultivation, but also because of its correlation with the "bunch" or erect characteristic of the plants. Variety GA-119-20 has the lowest values in the Virginia group of varieties.

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Variety	f.d. (g)	size of pods (long. max. cm)
Argentine	1,087	24.24 ± .31
Bunch - G2	813	35.09 ± .70
NC - 2	772	35.25 ± .58
Palma	787	28.01 ± .52
Virginia Jumbo	728	35.71 ± .62
Moruno	671	37.62 ± .69
GA - 119-20	592	37.75 ± .40
Cacahua (s.e. : 30)	585	46.02 ± .82

Table 1. Detachment force of the pods (g) and max. length of the pods (cm) of the eight varieties tested.

Variety	width of clod (cm)	depth of clod (cm)	l.p. (cm)
Moruno	17.4	15.10	7.64 ± .31
Bunch G-2	17.3	13.15	8.70 ± .30
NC - 2	17.1	14.35	7.12 ± .23
Virg. Jumbo	16.8	13.00	7.64 ± .31
GA 119-20	16.8	14.20	6.46 ± .23
Palma	15.9	12.70	7.09 ± .23
Argentine	15.3	11.00	4.15 ± .19
Cacahua	15.8 (s.e.: .54)	12.55 (s.e.: .44)	6.35 ± .26

Table 2. Width and depth of the clod of pods and earth and length of the peduncles, in the eight varieties (in cm ,

Variety	suture paralell (h.m.)	suture paralell (l.m.)	suture perpend (h.m.)	suture perpend (l.m.)
GA - 119-20	11.04	10.02	7.32	8.01
Palma	8.30	10.18	4.08	7.62
Cacahua	8.47	9.96	7.01	7.67
Moruno	8.65	8.61	6.52	6.35
Virg. Jumbo	8.17	8.65	5.12	6.53
NC - 2	7.60	8.44	5.08	6.17
Bunch G-2	7.96	7.53	4.37	6.21
Argentine	5.52 (s.e.: 0.46)	4.96	4.42 (s.e. 0.34)	4.51 . . . . .

Table 3. Resistance of the pods to compression, in kg, for two positions and two moisture contents: high moisture (h. m.) and low moisture (l. m.).

Variety	1 undamaged	2 damaged	3 suture open	4 holes	5 seeds free	Total
Argentine	25	5	61.5	7.5	1	100
Palma	20	1	59	19	1	100
Cacahua	16	2.5	9	46	26.5	100
NC-2	22	10	26	42	0	100
GA-119-20	33	24	27	16	0	100
Bunch G-2	24	11	32	33	0	100
Moruno	24	40	11	25	0	100
Virg. Jumbo	19	26	14	41	0	100

1 : undamaged, or very small scrapings

2 : important scrapings, no visible penetration of air

3 : open carpelar suture, always starting at the apex

4 : round holes or cracks, starting always at the apex

5 : free shells and seeds, or pods with holes sufficient to free the seeds.

Table 4. Percentage of each type of damage in a three-hour test with the rotating device.

Fig. 1. Rotating parallelepipedic prism for dy - namic tests.

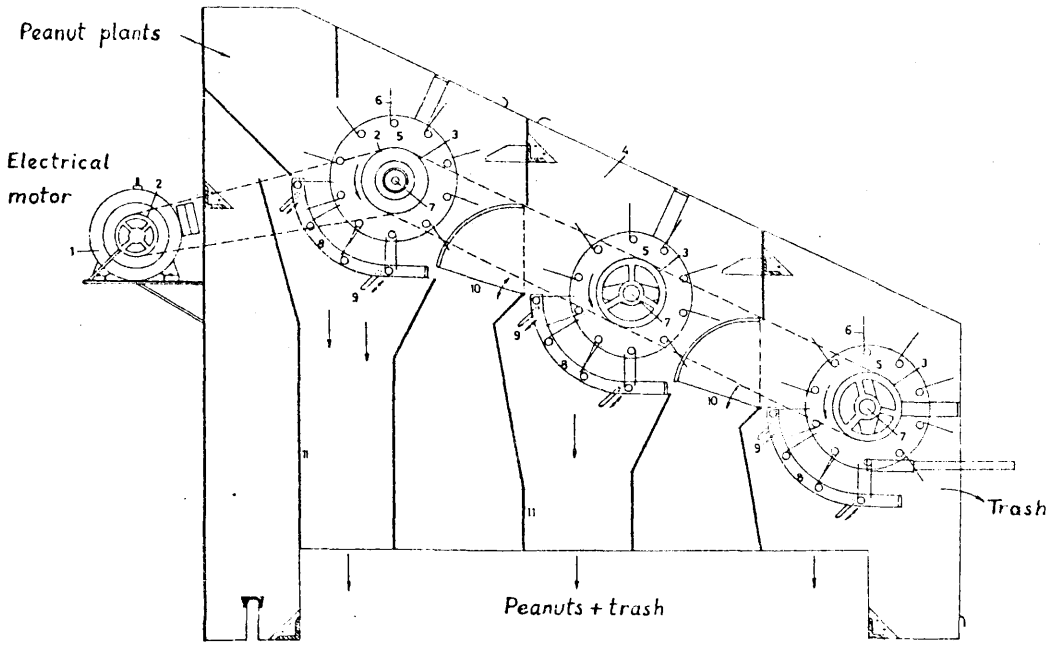

Fig. 2. Laboratory mechanical picking machine.

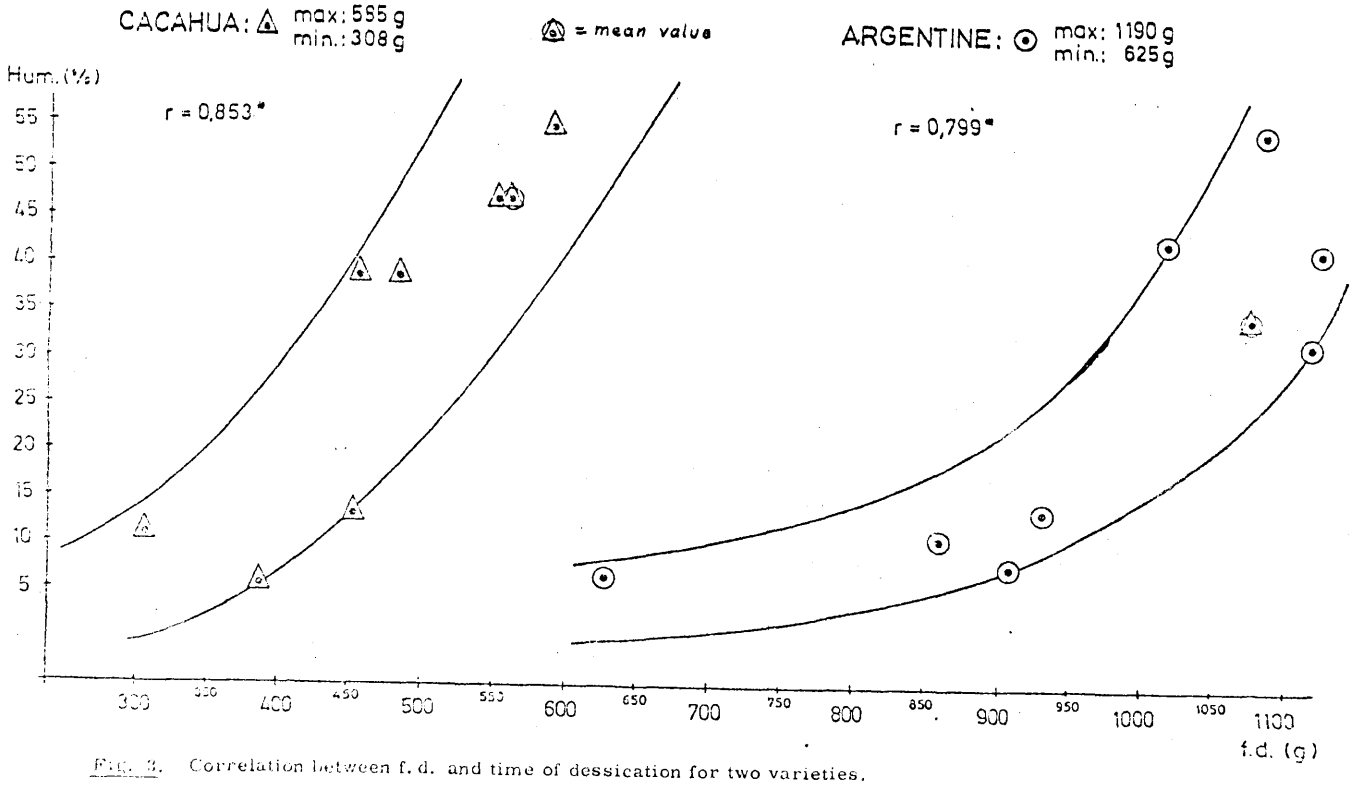

Fig. 3. Correlation between f. d. and time of dessication for two varieties.

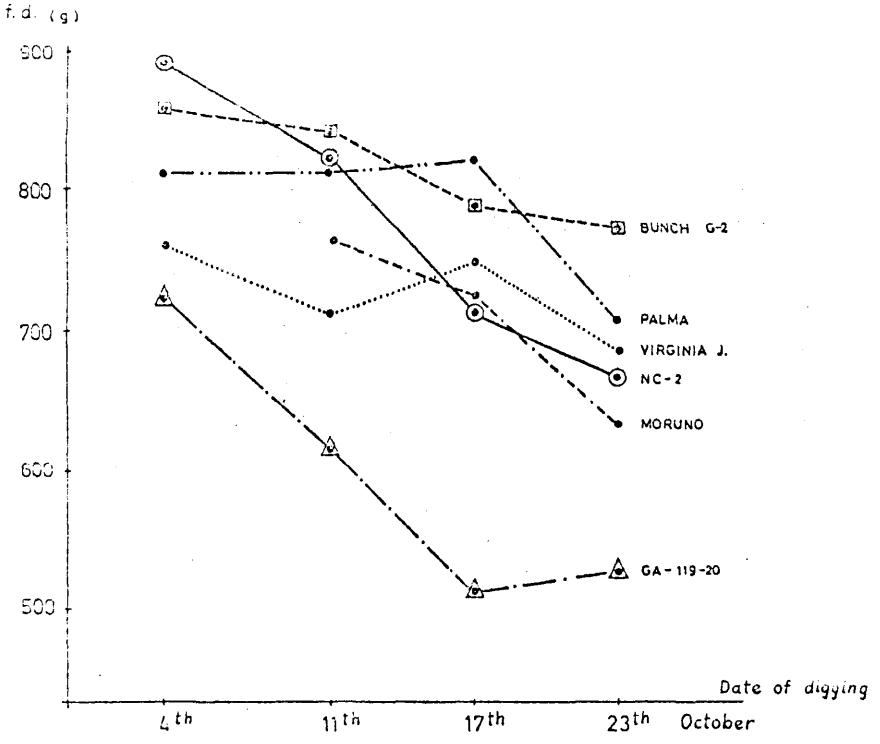

Fig. 4. Variation of the f. d. during the last two weeks of maturation of the plants in the soil.

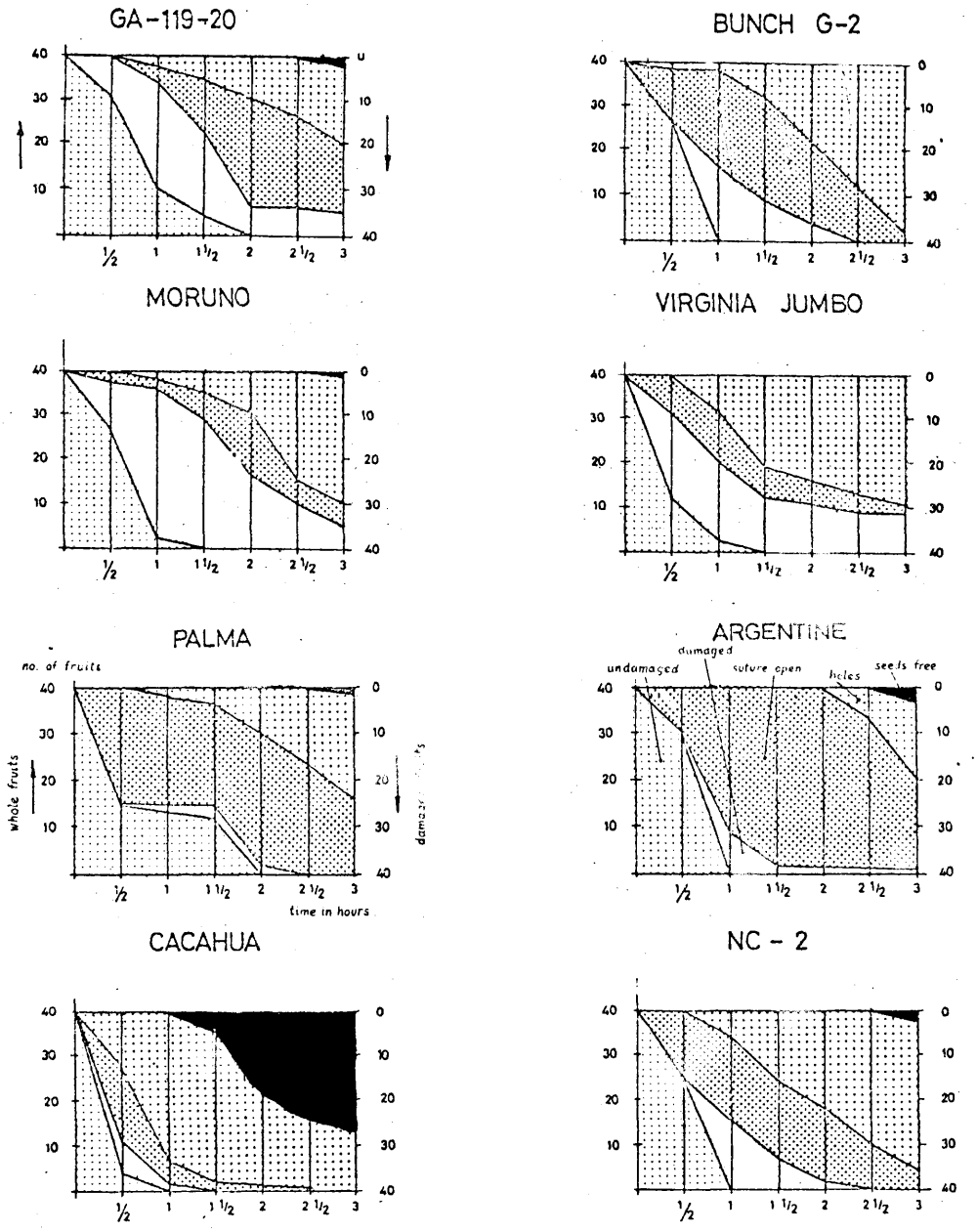

Fig. 5. Incidence of the different types of damages in the tests with the rotating prism.

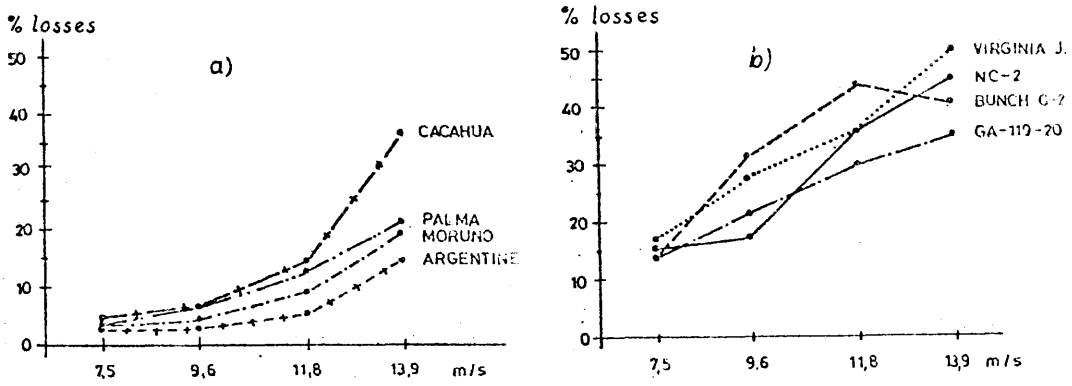

Fig. 6. Percentage of losses with increasing peripheral velocity of the picking cylinders. a) four earlier varieties, low moisture; b) four later varieties, high moisture.